

AD-A264 672



ITATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE March 1993		3. REPORT TYPE AND DATES COVERED Professional Paper	
4. TITLE AND SUBTITLE A TERRAIN PARABOLIC EQUATION MODEL (TPEM)				5. FUNDING NUMBERS PR: CDB6 PE: 0602435N WU: DN488760	
6. AUTHOR(S) A. E. Barrios				8. PERFORMING ORGANIZATION REPORT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Command, Control and Ocean Surveillance Center (NCCOSC) RDT&E Division San Diego, CA 92152-5001				10. SPONSORING/MONITORING AGENCY REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) Naval Command, Control and Ocean Surveillance Center (NCCOSC) RDT&E Division San Diego, CA 92152-5001				11. SUPPLEMENTARY NOTES	
12a. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.				12. DISTRIBUTION STATEMENT A	
13. ABSTRACT (Maximum 200 words) A numerically efficient method has been developed to model tropospheric radiowave propagation over irregular terrain in the presence of range-dependent, non-standard environmental conditions. The model is based on a modification to the smooth-earth parabolic equation, and uses the split-step Fourier algorithm developed by Hardin and Tappert.					
<div style="display: flex; justify-content: space-between; align-items: flex-end;"> <div style="text-align: center;"> <p>93 5 20 1 6</p> <p>Published in <i>VRSI National Radio Science Meeting Proceedings</i>, Jan 1993, p 107.</p> </div> <div style="text-align: right;"> <p>93-11407</p> </div> </div>					
14. SUBJECT TERMS propagation assessment environmental data command and control tactical decision aids				15. NUMBER OF PAGES	
				16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT UNCLASSIFIED	18. SECURITY CLASSIFICATION OF THIS PAGE UNCLASSIFIED	19. SECURITY CLASSIFICATION OF ABSTRACT UNCLASSIFIED	20. LIMITATION OF ABSTRACT SAME AS REPORT		

UNCLASSIFIED

1a NAME OF RESPONSIBLE INDIVIDUAL A. E. Barrios	2b TELEPHONE (Include Area Code) (619) 553-1429	2c GRADE OR MSG NO Code 543																				
<div> <table border="1"> <tr> <td colspan="2">Assignment For</td> </tr> <tr> <td>NTIS - CRA2</td> <td><input checked="" type="checkbox"/></td> </tr> <tr> <td>D - J - TAE</td> <td><input type="checkbox"/></td> </tr> <tr> <td>U - J - D - J - J</td> <td><input type="checkbox"/></td> </tr> <tr> <td>J - J - J - J - J</td> <td><input type="checkbox"/></td> </tr> <tr> <td colspan="2">By</td> </tr> <tr> <td colspan="2">Date</td> </tr> <tr> <td colspan="2">Approved By</td> </tr> <tr> <td>Post</td> <td>Approved</td> </tr> <tr> <td>A-1</td> <td>20</td> </tr> </table> </div>			Assignment For		NTIS - CRA2	<input checked="" type="checkbox"/>	D - J - TAE	<input type="checkbox"/>	U - J - D - J - J	<input type="checkbox"/>	J - J - J - J - J	<input type="checkbox"/>	By		Date		Approved By		Post	Approved	A-1	20
Assignment For																						
NTIS - CRA2	<input checked="" type="checkbox"/>																					
D - J - TAE	<input type="checkbox"/>																					
U - J - D - J - J	<input type="checkbox"/>																					
J - J - J - J - J	<input type="checkbox"/>																					
By																						
Date																						
Approved By																						
Post	Approved																					
A-1	20																					

A TERRAIN PARABOLIC EQUATION MODEL (TPEM)

Amalia E. Barrios

Naval Command, Control and Ocean Surveillance Center

RDT&E Division, Code 543

San Diego, CA 92152-5000

A numerically efficient method has been developed to model tropospheric radiowave propagation over irregular terrain in the presence of range-dependent, non-standard environmental conditions. The model is based on a modification to the smooth-earth parabolic equation, and uses the split-step Fourier algorithm developed by Hardin and Tappert (*SIAM Rev.* 15, p. 423, 1973).

For radiowave propagation over terrain, the parabolic equation (PE) is subject to a range-dependent boundary condition, specifically, that the field is zero at the surface (assuming horizontal polarization). Since the surface is constantly changing for any arbitrary terrain, this poses a formidable problem. The method developed here is based on "transforming" the PE through a change of variables and determining a new "modified" PE with a new *range-independent* boundary condition that is now easily solved. This transformation is equivalent to defining a new modified refractivity that includes a term based on the second derivative of the terrain. Conceptually, the modified refractivity, which normally accounts for the earth's curvature, is now used with an additional term to take into account the radius of curvature of each segment of the terrain.

Comparisons are made between TPEM and other existing terrain models, and against measured data. The figure below is a coverage diagram from TPEM for a terrain path in Alberta, Canada.

